Stratospheric temperature structure and characteristics of gravity waves during stratospheric sudden warming events

*Yukari Sumi[1], Kaoru Sato[1]

1. University of Tokyo

Stratospheric sudden warming (SSW) is an event, in which the temperature in the polar winter stratosphere raises by several tens of degrees in a few days. The strong warming is associated with an enhanced downward branch of the Lagrangian mean flow driven by a strong planetary wave forcing. Recent studies suggest that gravity waves (GWs) can also affect the evolution of SSW, although it has not yet been fully understood. We investigate the characteristics of GWs in the Arctic stratosphere during the SSW events in 2016 and 2017. Wave activity is estimated from dry temperature data from the FORMOSAT-3/COSMIC satellite. The synoptic-scale structure of the stratosphere is analyzed using MERRA-2 reanalysis data. It is seen in the MERRA-2 data that during the SSW event in February 2016, a front-like temperature structure in the boundary between anomalously warm and cold areas caused by an SSW is observed in the stratosphere. The temperature gradient reaches a maximum slightly prior to the SSW event in the pressure range between 40 hPa and 2 hPa, namely with a depth of about 20 km. We further calculate a frontogenesis function, the Lagrangian change rate of the magnitude of the horizontal potential temperature gradient, to quantify the frontal strength and time scale of the frontal development. It is shown that the frontogenesis function is largely positive on the warmer side of the front. The temperature perturbations due to GWs are extracted by applying a highpass filter to individual vertical profile of the COSMIC temperature. The cutoff wavelength of 6 km is used for the highpass filter, which is shorter than used in previous studies (10 to 15 km). This is essential because longer cutoff wave lengths may cause significant contamination from the front-like structure having the vertical scale of 10 to 20 km. The GW potential energy is large in the height region of 25-35 km during the SSW events. We will show detailed characteristics of the observed GWs and also discuss the relation to the front-like structure.

